LISTING OF CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in this application:

1. (Currently amended) A method for automatic correction of motion artifacts in an interlaced video image captured by an image recording camera, comprising:

capturing a complete frame of an interlaced video image, the complete frame having a first raster field and an interlaced second raster field;

automatically correcting for camera motion, comprising locating optimal correlation values for each pixel in the first raster field relative to a reference pixel in the second raster field to create a two-dimensional motion vector between each pixel in the first raster field and the reference pixel in the second raster field;

automatically correcting for subject motion; and

displaying an image corrected for camera motion and subject motion.

2. (Original) The method of claim 1, wherein automatically correcting for camera motion comprises determining whether the captured frame contains camera motion artifacts.

3. (Original) The method of claim 2, wherein automatically correcting for camera motion comprises performing auto-correlation on the first raster field with respect to the second raster field.

4. (Original) The method of claim 3, the first and second raster fields each having a plurality of pixels and pixels in the first raster field are offset from pixels in the second raster field, wherein performing auto-correlation comprises creating a two-dimensional motion vector between pixels in the first raster field and pixels in the second raster field.

5. (Original)   The method of claim 4, wherein creating a two-dimensional motion vector comprises locating optimal correlation values for X/Y coordinates for each pixel in the first raster field relative to a reference pixel in the second raster field.

6. (Original)   The method of claim 5, wherein locating optimal correlation values comprises using a repeating 3x3 convolution search.

7. (Original)   The method of claim 6, wherein using a repeating 3x3 convolution search comprises

(a) determining a first correlation value for corresponding pixels in the first and second raster fields when a first specified offset is zero for both X and Y coordinates,

(b) determining a second correlation value for a pixel in the first raster field to the right of the corresponding pixel in the second raster field when a second specified offset is one for X and zero for Y,

(c) calculating a difference between the first correlation value and the second correlation value,

(d) squaring the difference between the values,

(e) repeating steps (a), (b), (c), and (d) for all pixels in the first raster field relative to pixels in the second raster field,

(f) adding the squares of the differences between correlation values at the first specified offset and at the second specified offset, and

(g) determining the correlation values which produce a minimum difference between pixels in the first raster field and the second raster field to provide optimal correlation values for shifting the first raster field relative to the second raster field.

8. (Original)   The method of claim 4, wherein creating a two-dimensional motion vector comprises locating values for X/Y coordinates for each pixel in the first raster field determined to be offset more than 15 pixels from a reference pixel in the second raster field.

9. (Original) The method of claim 3, wherein automatically correcting for camera motion further comprises creating a synthetic first raster field by duplicating the second raster field.

10. (Original) The method of claim 4, wherein creating a synthetic first raster field by duplicating the second raster field comprises replacing the first raster field with the duplicated second raster field in the captured complete frame in a corrected position according to the auto-correlation determined by the two-dimensional motion vector.

11. (Original) The method of claim 1, wherein automatically correcting for subject motion comprises computing a subject motion map to automatically identify regions of subject motion in the captured frame.

12. (Original) The method of claim 11, wherein computing a subject motion map comprises

(a) determining actual pixel values for the first raster field,

(b) computing predicted pixel values for the first raster field from the second raster field,

(c) comparing the predicted pixel values and the actual pixel values for the first raster field to determine differences between the first and second raster fields in discrete regions of the captured frame,

(d) identifying regions of the captured frame where differences between the first and second raster fields are relatively large, and

(e) squaring the relatively large differences between the first and second raster fields to generate the subject motion map.

13. (Original) The method of claim 12, wherein computing a subject motion map further comprises convolving the first and second raster fields of the captured frame to produce a half-height grayscale image map in regions of large differences in the subject motion map, and

leaving uncorrected regions of the captured frame where differences between the first and second raster fields are relatively small.

14. (Original)   The method of claim 11, wherein automatically correcting for subject motion further comprises creating a binary subject location map to delineate regions of the captured frame for applying correction for subject motion.

15. (Original)   The method of claim 14, wherein creating a binary subject location map comprises

(a) establishing a threshold difference between the predicted pixel values and the actual pixel values for the first raster field,

(b) comparing each pixel in the grayscale image map to the threshold difference, counting the number of pixels exceeding the threshold difference,

(c) eliminating from the grayscale image map pixels where three or less neighboring pixels in the grayscale image map are above the threshold difference, and

(d) leaving in the grayscale image map pixels where more than three neighboring pixels are above the threshold difference.

16. (Original)   The method of claim 15, wherein the threshold difference is in the range from about 20 to about 150 IRE brightness units.

17. (Original)   The method of claim 15, wherein the threshold difference is 80 IRE brightness units.

18. (Original)   The method of claim 15, wherein automatically correcting for subject motion further comprises adjusting the binary subject location map by replacing pixels eliminated from the grayscale image map in regions of subject motion.

19. (Original)   The method of claim 18, the regions of subject motion having pixels eliminated forming boundaries comprising pixels, wherein adjusting the binary subject location map comprises

(a) computing a two-dimensional vector from pixels at the boundaries of eliminated regions of subject motion,

(b) replacing pixels eliminated from regions of subject motion with the two-dimensional vector, and

(c) repeating steps (a) and (b) by computing the two-dimensional vector at locations one pixel further away from the boundaries of the eliminated regions of subject motion to create a corrected image having smooth edges.

20. (Original)   The method of claim 19, wherein computing a two-dimensional vector from pixels at the boundaries of eliminated regions of subject motion comprises identifying boundaries of eliminated regions of subject motion, and detecting pixels in two directions, one pixel at a time, adjacent to the pixels at the boundaries.

21. (Original)   The method of claim 19, wherein automatically correcting for subject motion further comprises computing a finished, corrected image.

22. (Original)   The method of claim 21, wherein computing a finished, corrected image comprises using the adjusted map to indicate regions on the captured frame where subject motion is greatest, and computing a corrected second raster field from a corrected first raster field in regions on the captured frame where subject motion is greatest.

23. (Original)   The method of claim 22, further comprising displaying the finished image corrected for camera motion and subject motion.

24. (Original)   The method of claim 1, further comprising automatically correcting for subject motion after automatically correcting for camera motion.

25. (Original)   The method of claim 1, wherein capturing the complete frame of the interlaced video image comprises capturing video images taken during surgical procedures.

26. (Original)   A method for automatic correction of motion artifacts in an interlaced video image captured by an image recording camera, comprising:

capturing a complete frame of an interlaced video image, the complete frame having a first raster field and an interlaced second raster field, the first and second raster fields each having a plurality of pixels;

locating optimal correlation values between pixels in the first raster field and pixels in the second raster field;

creating a two-dimensional motion vector from optimal correlation values;

creating a synthetic first raster field by duplicating the second raster field in the captured complete frame in a corrected position according to the two-dimensional motion vector;

computing a subject motion map to identify regions of the captured frame where differences in pixel values between the first and second raster fields are relatively large;

creating a binary subject location map to delineate regions of the captured frame for applying correction for subject motion;

eliminating from the binary subject location map pixels where the number of neighboring pixels exceeds a pre-determined threshold;

adjusting the binary subject location map by replacing eliminated pixels;

computing a finished, corrected image; and

displaying the image corrected for camera motion and subject motion.

27. (Currently amended)   A system for automatic correction of motion artifacts in a live, interlaced video image, the system comprising:

an image recording camera for capturing complete frames of video images;

a digital capture unit for processing live video images and captured frames of video images;

a first filter for automatically correcting for camera motion <u>comprising a two-dimensional</u> <u>motion vector between each pixel in the first raster field and a reference pixel in the second</u> <u>raster field formed from optimal correlation values for each pixel in the first raster field relative</u> <u>to the reference pixel in the second raster field</u>;

a second filter for automatically correcting for subject motion; and

a video monitor for displaying images.

28. (Original)   The system of claim 27, the complete frames each having a first raster field and an interlaced second raster field, each field comprising a plurality of pixels, wherein the first filter for automatically correcting for camera motion comprises

a two-dimensional motion vector between the first and second raster fields created by auto-correlation, and

a synthetic first raster field created by duplicating the second raster field in a corrected position in the captured complete frame according to the two-dimensional motion vector.

29. (Original)   The system of claim 28, wherein the second filter for automatically correcting for subject motion comprises

a subject motion map computed to identify regions of subject motion,

a binary subject motion map for eliminating pixels in the regions of subject motion,

an adjusted binary subject motion map, the binary subject motion map adjusted by replacing eliminated pixels, and

a corrected captured frame, the frame corrected by computing a corrected second raster field from the first raster field in regions where subject motion is greatest.

30. (Original)   The system of claim 27, wherein the video monitor for displaying images comprises images displayed before and after correction for camera motion and for subject motion.

31. (Original)   The system of claim 27, wherein the system further comprises a freeze mode for freezing live video images and displaying frozen images on the video monitor.

32. (Original)   The system of claim 31, wherein the system further comprises a capture mode for digitally capturing frozen images by the digital capture unit.

33. (Original)   The system of claim 32, the digital capture unit having an internal temporary storage capacity, wherein the system further comprises a save mode for saving images corrected for camera motion and subject motion in the internal temporary storage of the digital capture unit.

34. (Original)   The system of claim 33, the system having a media writer for permanently saving images onto portable storage media, wherein the system further comprises a write mode for permanently saving images corrected for camera motion and subject motion onto portable storage media.

REMARKS

The following remarks are submitted to address the above amendments and issues raised in the Official Action mailed December 3, 2003.

A Request for Extension of Time, and payment therefor, to extend the period for filing a response to this Official Action for one month to April 3, 2004, is filed herewith.

Upon entry of the foregoing amendments, claims 1-34 are now pending in this application.

Claims 1, 2, 11, 14, 24, 27, and 30 stand rejected under 35 USC § 102(b), as being anticipated by Bozdagi (U.S. Patent No. 5,784,115). Claims 3-5, 9, 10, and 28 stand rejected under 35 USC § 103(a), as being unpatentable over Bozdagi in view of Topper (U.S. Patent No. 6,545,719). Claim 25 stands rejected under 35 USC § 103(a), as being unpatentable over Bozdagi. Claims 31-34 stand rejected under 35 USC § 103(a), as being unpatentable over Bozdagi in view of Branson (U.S. Patent No. 5,877,819). Claims 6-8, 12, 13, 15-23, and 29 stand objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claims and any intervening claims. Claim 26 stands allowed.

No new matter has been added. Support for requested amendments can be found in the original claims and throughout the present specification and drawings. Applicant respectfully requests consideration of the application in light of the above amendments and the following remarks.

Claims 1, 2, 11, 14, 24, 27, and 30 — 35 USC § 102(b)

The rejections of claims 1, 2, 11, 14, 24, 27, and 30 under 35 USC § 102(b) as being anticipated by Bozdagi are respectfully traversed.

Claim 1 of the present invention, as amended, claims "[a] method for automatic correction of motion artifacts in an interlaced video image captured by an image recording camera, comprising: capturing a complete frame of an interlaced video image, the complete frame having a first raster field and an interlaced second raster field; automatically correcting for camera motion, comprising *locating optimal correlation values for each pixel in the first raster field relative to a reference pixel in the second raster field* to *create a two-dimensional motion vector* between each pixel in the first raster field and the reference pixel in the second raster field; automatically correcting for subject motion; and displaying an image corrected for camera motion and subject motion." (Claim 1, emphasis added.)

Claim 27 of the present invention, as amended, claims "[a] system for automatic correction of motion artifacts in a live, interlaced video image, the system comprising: an image recording camera for capturing complete frames of video images; a digital capture unit for processing live video images and captured frames of video images; a first filter for automatically correcting for camera motion comprising *a two-dimensional motion vector* between each pixel in the first raster field and a reference pixel in the second raster field formed *from optimal correlation values for each pixel in the first raster field relative to the reference pixel in the second raster field*; a second filter for automatically correcting for subject motion; and a video monitor for displaying images." (Claim 27, emphasis added.)

The Official Action states that Bozdagi discloses capturing a complete frame of an interlaced video image, the complete frame having a first raster field and an interlaced second raster field; automatically correcting for camera motion; automatically correcting for subject motion; and displaying an image corrected for camera motion and subject motion. The Official Action states that Bozdagi discloses an image recording camera for capturing frames of video images; a first filter for automatically correcting for camera motion comprising; a second filter for automatically correcting for subject motion; and a video monitor for displaying images. (Official Action, para. 2.)

Bozdagi discloses a system and method for motion compensated de-interlacing of video frames that involves calculating the average gray level in a 1 x 3 pixel block for both even and odd raster fields, and comparing the difference between these average gray level values against *a predetermined threshold* to determine which gray level value, 0 or 255, to assign to the pixel. (Bozdagi, col. 7, line 53 – col. 8, line 18 (emphasis added).)

Nowhere does Bozdagi disclose a method or system for automatic correction of motion artifacts that locates *optimal correlation values* for *each pixel* in the first raster field *relative to a reference pixel* in the second raster field to create a two-dimensional motion vector, as in claims 1 and 27 of the present application. In contrast, Bozdagi discloses estimating motion by mapping one image into another based on *threshold* differences between images, and not by actual measured correlation values for each pixel as in claims 1 and 27.

For all of these reasons, the Office is respectfully requested to withdraw the rejections of claims 1, 2, 11, 14, 24, 27, and 30 under 35 USC § 102(b).

Claims 3-5, 9, 10, and 28 — 35 USC § 103(a)

The rejections of claims 3-5, 9, 10, and 28 under 35 USC § 103(a) as being unpatentable over Bozdagi in view of Topper are respectfully traversed.

The Official Action states that Bozdagi does not disclose "performing auto-correlation on the first raster field with respect to the second raster field" as claimed in claim 3, but that Topper discloses performing auto-correlation that would result in an improved quality image, and that an artisan would be motivated to combine the references to arrive at the claimed invention such that the claimed invention would have been obvious to a person of ordinary skill in the art at the time the invention was made. (Official Action, para. 4.)

As discussed herein, Bozdagi fails to disclose a method or system for automatic correction of motion artifacts that locates *optimal correlation values* for *each pixel* in the first raster field *relative to a reference pixel* in the second raster field to create a two-dimensional motion vector, as in claims 1 and 27 of the present application. In contrast, Bozdagi discloses estimating motion by mapping one image into another based on *threshold* differences between images, and not by actual measured correlation values for each pixel, as in claims 1 and 27. In addition, Bozdagi does not disclose "auto-correlation" for determining a motion vector, as in claims 3-5, 9, 10, and 28 of the present invention. Rather, Bozdagi teaches a less direct map shift by controlling the affine transform, a complex warp method calculation for curved adjustments. (Bozdagi, col. 8, line – col. 9, line 2.) As such, Bozdagi is deficient as a reference for claims 1, 3-5, 9, 10, 27, and 28.

Topper also does not disclose a method or system for automatic correction of motion artifacts that locates *optimal correlation values* for *each pixel* in the first raster field *relative to a reference pixel* in the second raster field to create a two-dimensional motion vector, as in claims 1 and 27 of the present invention. Accordingly, Topper fails to overcome the deficiency of Bozdagi as a reference. Moreover, both Bozdagi and Topper disclose determining motion using *blocks of pixels*, for example an 8 x 8 block of pixels (by estimating affine parameters in Bozdagi and by measuring displacement in Topper). (Bozdagi, col. 9, lines 22-29; Topper, col. 6, lines 8-32.) As such, neither Bozdagi or Topper disclose locating *optimal correlation values* for *each pixel* in the first raster field *relative to a reference pixel* in the second raster field, as in claims 1 and 27 of the present invention. Therefore, Applicant respectfully submits that the combination of these two references does not teach or suggest each and every element of the present invention, nor does either reference suggest such a combination. As a result, claims 1 and 27 of the present invention are not obvious over Bozdagi in view of Topper. Claims 3-5, 9, and 10 are dependent on claim 1, and claim 28 is dependent upon claim 27. Accordingly, claims 3-5, 9, 10, and 28 would not have been not obvious in view of these two references.

For all of these reasons, the Office is respectfully requested to withdraw the rejections of claims 3-5, 9, 10, and 28 under 35 USC § 103(a).

Claim 25 — 35 USC § 103(a)

The rejection of claim 25 under 35 USC § 103(a) as being unpatentable over Bozdagi is respectfully traversed.

The Official Action states that Bozdagi 's disclosure is not limited to a specific environment, that an artisan would be motivated to use Bozdagi's disclosure in a medical environment to provide high quality images for examination, for instance during surgical procedures, and that the invention in claim 25 would therefore have been obvious to a person of ordinary skill in the art at the time the invention was made. (Official Action, para. 5.)

As discussed herein, Bozdagi fails to disclose "[a] method for automatic correction of motion artifacts . . . comprising *locating optimal correlation values for each pixel in the first raster field relative to a reference pixel in the second raster field* to *create a two-dimensional motion vector* between each pixel in the first raster field and the reference pixel in the second raster field . . . ", as in claim 1 of the present invention. (Claim 1 (emphasis added).) As such, Bozdagi is deficient as a reference. The examiner's assertion that an artisan would be motivated to use Bozdagi's disclosure in a medical environment to provide high quality images for examination does not overcome this deficiency. Therefore, Applicant respectfully submits that a method for estimating motion that involves calculating the average gray level in a block of pixels and comparing the difference between the average gray level values against *a predetermined threshold* to map one image into another, as disclosed in Bozdagi, neither teaches or suggests each and every element of the present invention. Neither does Bozdagi provide any suggestion for using a method for *locating optimal correlation values for each pixel in the first raster field relative to a reference pixel in the second raster field* to *create a two-dimensional motion vector* during surgical procedures, as in claim 25. As a result, claim 1 of the present invention is not

obvious over Bozdagi. Claim 25 is dependent on claim 1, and would not have been not obvious in view of Bozdagi.

For all of these reasons, the Office is respectfully requested to withdraw the rejection of claim 25 under 35 USC § 103(a).

Claims 31-34 — 35 USC § 103(a)

The rejections of claims 31-34 under 35 USC § 103(a) as being unpatentable over Bozdagi in view of Branson are respectfully traversed.

The Official Action states that Bozdagi does not disclose "a freeze mode for freezing live video images and displaying frozen images on the video monitor", as in claims 31-34, that Branson discloses freezing live video images, that an artisan would have been motivated to combine these references to arrive at the claimed invention, and that the claimed invention would have been obvious to a person of ordinary skill in the art at the time the invention was made. (Official Action, para. 6.)

As discussed herein, Bozdagi fails to disclose ". . . a first filter for automatically correcting for camera motion comprising *a two-dimensional motion vector* between each pixel in the first raster field and a reference pixel in the second raster field formed *from optimal correlation values for each pixel in the first raster field relative to the reference pixel in the second raster field* . . .", as in claim 27 of the present invention. As such, Bozdagi is deficient as a reference. Branson also does not disclose a motion vector formed in such a manner, and thus fails to overcome this deficiency. Therefore, Applicant respectfully submits that the combination of these two references does not teach or suggest each and every element of the present invention, nor does either reference suggest such a combination. As a result, claim 27 of the present invention is not obvious over Bozdagi in view of Branson. Claims 31-34 are dependent on claim 27, and therefore would not have been not obvious in view of these two references.

For all of these reasons, the Office is respectfully requested to withdraw the rejections of claims 31-34 under 35 USC § 103(a).

Claims 6-8, 12, 13, 15-23, and 29

The Official Action states that claims 6-8, 12, 13, 15-23, and 29 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. (Official Action, para. 7.)

As discussed herein, Applicant respectfully submits that Bozdagi does not teach each and every element of, and thus does not anticipate, claims 1 and 27 of the present invention. As such, neither claim 1 nor claim 27 should be a rejected claim. Accordingly, claims 6-8, 12, 13, 15-23, and 29, which depend from claims 1 and 27, are dependent upon a base claim that should not be rejected. Consequently, claims 6-8, 12, 13, 15-23, and 29 should be allowed as written.

For all of these reasons, the Office is respectfully requested to withdraw the objections to claims 6-8, 12, 13, 15-23, and 29 as being dependent upon a rejected base claim.

CONCLUSION

Applicant submits that a full and complete response has been made herein to the Official Action and, as such, all pending claims in this application are now in condition for allowance. Therefore, Applicant respectfully requests early consideration of the present application, entry of all amendments herein requested, withdrawal of all rejections and objections, and allowance of all pending claims.

The Office is respectfully invited to contact J. Michael Boggs at (336) 747-7536, to discuss any matter relating to this application.

Respectfully submitted,

___4/1/04___
Date

J. Michael Boggs
J. Michael Boggs
Reg. No. 46,563

Kilpatrick Stockton LLP
1001 West Fourth Street
Winston-Salem, NC 27101
(336) 747-7536
(336) 734-2632 (facsimile)

10499-199668
WINLIB01:1064320.1